ANNUAL NEW MEXICO MINERAL SYMPOSIUM

39th Annual New Mexico Mineral Symposium

November 10 & 11, 2018

Mineral photos by Jeff Scovil

Featured speaker: Dr. Peter K.M. Megaw,
The Santa Eulalia Mining District, Chihuahua, Mexico

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New Mexico Mineral Symposium

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NEW MEXICO BUREAU OF GEOLOGY AND MINERAL RESOURCES

A DIVISION OF NEW MEXICO TECH

Socorro 2018

WELCOME TO

The 39th Annual
New Mexico Mineral Symposium

November 10 and 11, 2018

Macey Center Auditorium
New Mexico Institute of Mining and Technology
Socorro, New Mexico

The Mineral Symposium is sponsored each year by the Mineral Museum at the New Mexico Bureau of Geology and Mineral Resources.

Additional sponsors this year include:

Albuquerque Gem and Mineral Club
Chaparral Rockhounds
Los Alamos Geological Society
Grant County Rolling Stones
Friends of Mineralogy
White Mountain Gem and Mineral Club
Friends of Minerology-Colorado Chapter
City of Socorro

CITY OF SOCORRO

The New Mexico Mineral Symposium provides a forum for both professionals and amateurs interested in mineralogy. The meeting allows all to share their cumulative knowledge of mineral occurrences and provides stimulus for mineralogical studies and new mineral discoveries. In addition, the informal atmosphere allows for intimate discussions among all interested in mineralogy and associated fields.

New Mexico mineral photos on the cover by Jeff Scovil.

Cover: Top—*Bornite on chalcopyrite, San Pedro mine, New Placers District, Santa Fe Co., NM*; Middle—*Fluorite, Gila Fluorspar District, Grant Co., NM*; Bottom—*Barite and Fluorite, Hansonburg District, Socorro Co., NM*. All photos by Jeff Scovil.

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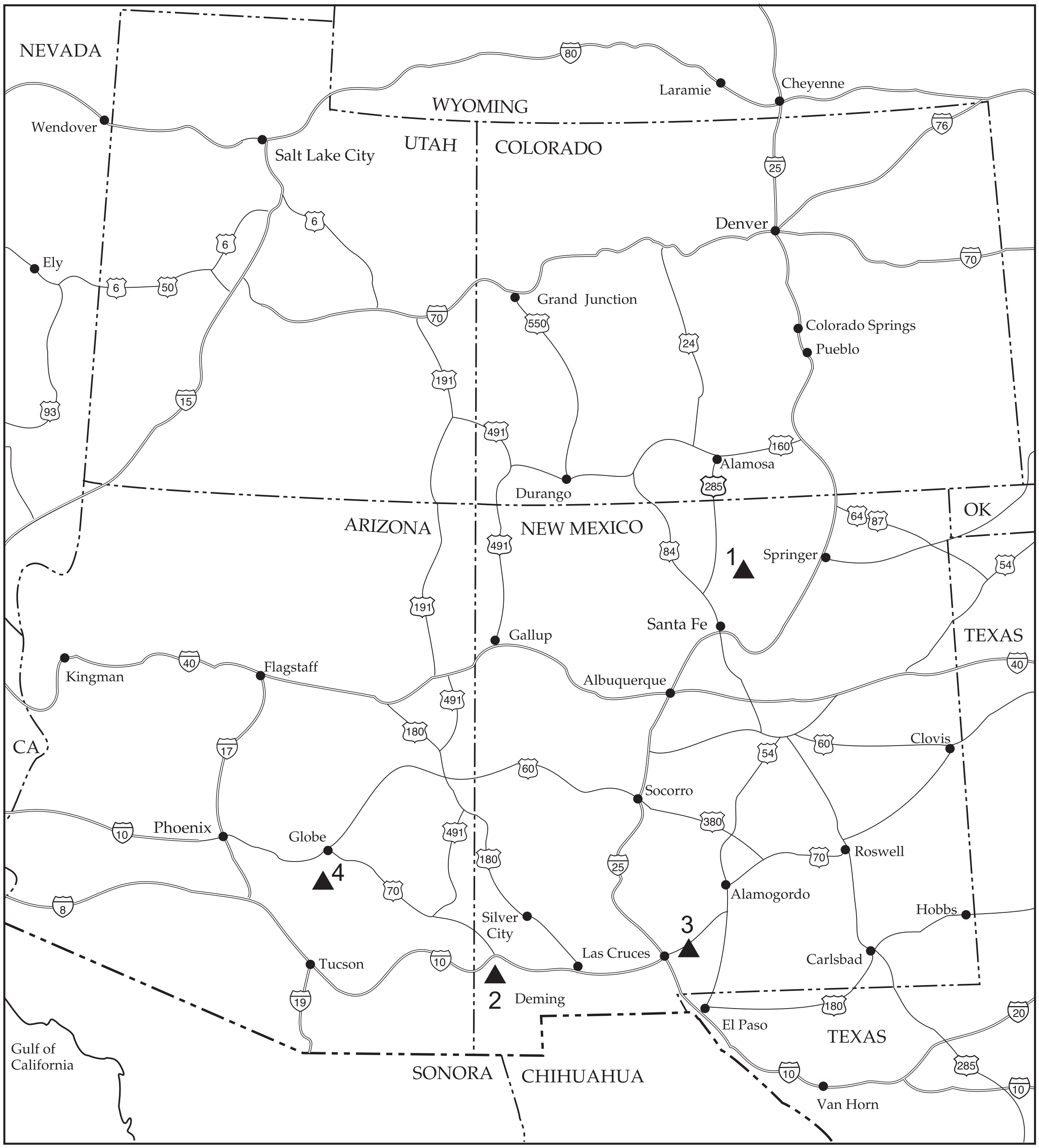

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SCHEDULE OF EVENTS

Friday, November 9th

8:00–5:00	Field Trip to Chupadera Mine, Socorro County, N.M. – Phillip Simmons, trip leader.
5:00–7:00 pm	Friends of the Museum Reception – Headen Center (Bureau of Geology) atrium. Appetizers and Cash Bar
7:00 pm	Informal motel tailgating and social hour, individual rooms, Comfort Inn & Suites (# 1 on map) and other venues—FREE

Saturday, November 10th

8:00 am	Registration, Macey Center; continental breakfast
8:50	Opening remarks, main auditorium
9:00	*"Electric Opal:" Mexico's Unique Daylight-luminescent hyalite opal* – Peter Megaw
9:30	*Collecting Geode Minerals in the American Midwest* – Terry Huizing
10:00	Coffee and burrito break
11:00	*Mineral and Gem Collecting in Indonesia: The Beginnings 1989–1995* – Mark I. Jacobson
11:30	*New discoveries at Copper Hill, Taos County, New Mexcio* – Ramon S. De Mark, Thomas Katonak, and Jesse Kline **(1)**
12:00 pm	Lunch and Museum tour
2:00	*Updated Mineral Lists; Atwood Hill area, Hidalgo County, New Mexico* – Robert Walstrom **(2)**
2:30	*Minerals of the Torpedo-Bennett Fault Zone, Organ Mountains, Doña Ana County, New Mexico* – Michael C. Michayluk **(3)**
3:00	Coffee break
3:30	*Capillitas Mine, Catamarca Province, Argentina,"The Other Rhodochrosite Locality"* – David Stoudt
4:00	*The Santa Eulalia Mining District, Chihuahua, Mexico* – Peter K.M. Megaw (**Featured Speaker**)
5:30	Sarsaparilla and suds: Cocktail hour, cash bar—Fidel Center Ballrooms
6:30	Silent Auction and Dinner followed by a voice auction to benefit the New Mexico Mineral Symposium—Fidel Center Ballrooms

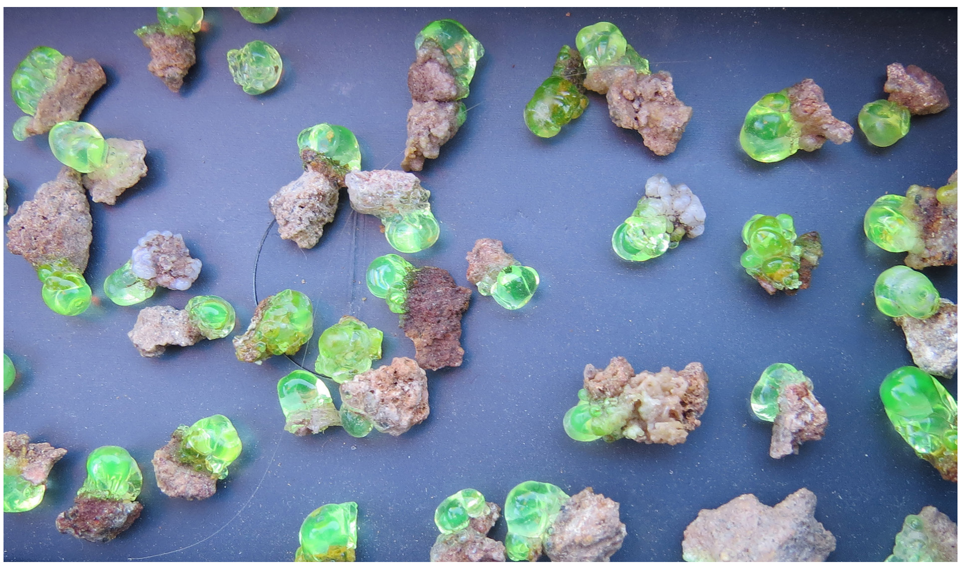
Sunday, November 11th

9:00 am–1:00 pm	Silent auction, lower lobby, Macey Center, sponsored by the Albuquerque Gem and Mineral Club for the benefit of the Mineral Museum (FREE)
8:00 am	Morning social, coffee and donuts
8:50	Welcome to the second day of the symposium and follow-up remarks
9:00	*Arizona Pseudomorphs* – Barbara Muntyan
9:30	*Arizona's Love Affair with Minerals, from Prehistory to Statehood* – Les Presmyk
10:00	Coffee break
10:30	*"Micromineraleering" in the 79* – Ron Gibbs **(4)**
11:00	*Color Stability in Minerals* – Virgil W. Lueth
11:30	*Australopithecus to Mindat – Mineralogy Through the Ages* – Nathalie N. Brandes and Paul T. Brandes
12:00 pm	Lunch

"Electric Opal": Green daylight-luminescing hyalite opal from Zacatecas, Mexico

Peter K.M. Megaw, IMDEX Inc., Tucson AZ USA pmegaw@imdex.com

Weathered specimens of botryoidal opal rough exhibiting a distinctive color-change phenomenon, appearing near-colorless or pale-to-moderate yellow in incandescent light; changing to chartreuse green in indirect sunlight first appeared in 2013. Not surprisingly, reaction by specimen collectors to this luminescence phenomenon was immediate and very positive, so reconnaissance prospecting was undertaken to determine quality and quantity of material available. This found that strongly-colored specimen material was sparsely distributed but did turn up a number of specimens composed of transparent lustrous *druplets* and blobs that showed strong color change, some of which appeared facetable. The specimens and initial cut gems attracted considerable attention, so long-term exclusive access was secured. The site lies at the top of a steep 250-meter-high mesa so mining was exclusively manual and lasted about a year until production dropped off and the project was abandoned.



The druplets are about 5 mm across, shot in incandescent light and shaded sunlight. *Peter Megaw specimens and photo by author.*

The hyalite occurs in mid-Tertiary caldera-related rhyolitic rocks typical of the Sierra Madre Occidental Volcanic Province in the northwestern part of Zacatecas State, Mexico. Devitrification of these units liberated silica, uranium, iron and other constituents from the decomposing volcanic glass, which initially went into volcanic vapors emanating from the cooling pile and circulating heated groundwaters that emerged as hot-springs. Devitrification continued more slowly after the volcanic pile cooled off; releasing constituents into descending surface waters. Silica liberated at higher temperatures tended to precipitate as chalcedony or fine-grained quartz, whereas at lower temperatures opal was deposited. Uranium and other liberated elements were also redeposited, in some cases as discrete species and in others within the framework structure of the chalcedony or opal. Several acicular uranium-containing minerals are found with and within the opal. Where encapsulated in opal, the uranium minerals are largely leached out leaving elongate tubes, some of which are marked by linear arrays of minute purple fluorite cubes that presumably crystallized on the elongate uranium minerals before they were covered and leached out. The most prominent uranium species were identified with X-ray diffraction and include meta-autunite ($Ca(UO_2)_2(PO_4)_2 \cdot 6–8H_2O$), haiweeite ($Ca(UO_2)_2[Si_5O_{12}(OH)_2] \cdot 6H_2O$), uranophane ($Ca(UO_2)_2(HSiO_4) \cdot 5H_2O$), meta-uranospinite ($Ca(UO_2)_2(AsO_4)_2 \cdot 8H_2O$) and boltwoodite [$(K,Na)(UO_2)(SiO_3OH) \cdot 1.5H_2O$].

The trillian is 5 ct, shot in filtered sunlight. *Smithsonian specimen, photo by Peter Megaw.*

The vertical specimen is 4 cm tall shot under filtered sunlight. *Peter Megaw specimen, photo by Jeff Scovil.*

Marketed as Electric Opal™ in allusion to the color change phenomenon, free-standing lustrous botryoids make the most attractive specimens with individual druplets making stand-alone jewelry pieces. The material facets beautifully and the faceted, color-changing opals captured the immediate attention of the gemstone world. Research to characterize the material in detail was swiftly undertaken, led by Emmanuel Fritsch of France. This work showed them to be Opal-AN, the amorphous (A), glass-like opal variety consisting of hydrated silica molecules that are network-forming (N). Also known as *hyalite*, **Opal-AN** does not have a regular array of spheres or any specific microstructure, so it is always 'common' opal and does not exhibit play-of-color like the familiar Australian or Ethiopian opals. Electric opal's luminescence is due to dispersed uranyl ions, and although it may locally contain up to 0.3% wt. % UO_2 where uranium species are visible, detailed radiation measurements recorded very low levels of emitted radioactivity from the opal itself: most "granite" kitchen countertops are more radioactive than this hyalite opal.

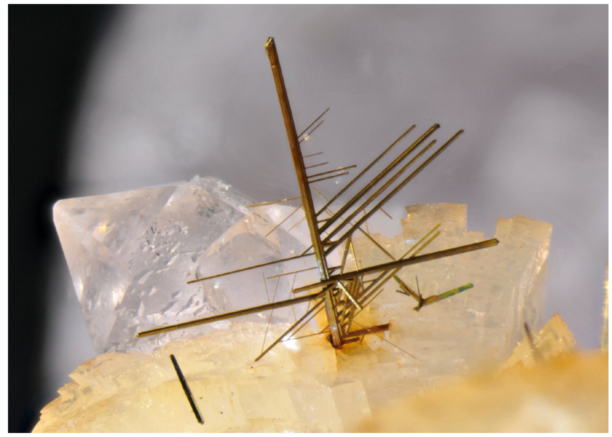
Hyalite covering a 3 cm ball of boltwoodite. shot under filtered sunlight. *Peter Megaw specimen, photo by Jeff Scovil.*

The main interest in this hyalite is its daylight-induced luminescence and why it is observed in this opal and in almost no other opals or other minerals. Several phenomena compete and combine for the perception of a color from an object: transmitted light (body color), reflected light (gloss) and scattered light ('haze' in colorimetric terms), which is commonly seen in milky gems (e.g. white diamond, jade or opal) or the blue adularescence of moonstone—luminescence is also a scattering phenomenon. Like most hyalite, Electric Opal is highly glossy, ranges from colorless to pallid yellow-green in daylight and fluoresces violently chartreuse under UV. What makes it different appears to be luminescence stimulated by uranyl ions dispersed in the opal that cause excitation in both the UV and the visible range with a maximum emission at 524 nm—in the visible range. It appears that perception of the green daylight luminescence stems from how this light is scattered before encountering the eye. The studies also indicate the influence of several other key factors: 1) Transparency—cloudy botryoids on the same samples do not fluoresce in daylight, 2) Absence of any sort of luminescence quencher, such as Fe^{3+}, and 3) The uranyl ions must be present within a certain range of concentration—if there is not enough, the luminescence is too weak, and if there is too much, the molecules absorb one another's emission through a process called *concentration quenching* or *self quenching*, which reduces the overall luminescence. In summary, it appears that this kind of daylight fluorescence is exceedingly rare because all of these conditions must be met for the phenomenon to occur.

Collecting geode minerals in the American Midwest

Terry E. Huizing

Aragonite, 4 cm. IN-37 roadcut 5 miles N. of Bloomington, Monroe Co., Indiana. *Dick Heck specimen. Rick Russell photo, 1986(MM).*



Marcasite (4 x 4 mm) on dolomite in quartz geode. Brummetts Creek, Bloomington, Monroe Co., Indiana. *Terry Huizing specimen #TEH 110, John Rakovan photo.*

A variety of spheroidal sedimentary structures occur in the American Midwest where they have been regarded as great curiosities. The rounded objects differ so much from the flat and layered rocks that host them that some have been given special names such as nodules, concretions, septaria, agates, and geodes. The focus of this talk is on geodes, perhaps the most interesting to the collector, because their often hollow centers may sometimes contain the surprise of beautiful and well-crystallized minerals.

Midwest geodes differ from and are easily separable from the carbonate rocks in which they occur. Geodes have an often thin, dense outer layer of microcrystalline, fibrous quartz (chalcedony) that is typically, but not always followed by an interior layer of white, interlocking, mosaic-textured crystalline quartz, and finally a center of inward-pointing quartz crystals. If growth is stopped early, that center remains open, providing a space in which other minerals may later crystallize.

Midwestern geodes occur only in rocks of Mississippian age, and while there are numerous outcrops where they may be found, this talk will cover the three most productive localities for minerals of collector interest: the Keokuk Geode Field, the Indiana Geode Field, and the Kentucky Geode Field.

For more information about Midwestern geodes, please refer to the article on this subject in the Jan/Feb 2017 issue of *Rocks & Minerals* magazine.

Mineral and gem collecting in Indonesia: The beginnings in 1989–1995

Mark Ivan Jacobson, 1714 S. Clarkson St., Denver, CO 80210

Indonesia is a collection of thousands of islands, representing mostly Tertiary to Recent volcanics rimming and mantling Paleozoic cratonic fragments. Accordingly, the diversity of its minerals is small and not historically well known since a mineral and gem collecting community only started with the rise in wealth of the country after independence in 1945 and the expulsion of the Dutch in 1949. Although mineral extraction is active throughout the country—gold, copper, lead, tin being major resources; minerals are rarely preserved. Between 1989 to 1995, I lived in Jakarta, and traveled within Java as well as to Sulawesi and Timor. During these travels, I field collected minerals that were available and photographed specimens seen in museums, markets and exhibitions. Mineral, gem, and lapidary dealers were just starting to surface as economic development increased. This presentation will share the beginnings of mineral collecting and dealing as it evolved. Some news of current, 2017 Indonesia mineral activities will also be described.

So how does one find minerals in Indonesia? Travel around the archipelago and keep an active open eye for opportunities to purchase, trade or self-collect, and reading the geologic literature which is mostly in English or Indonesian. Libraries in cities and universities are open to visitors; although they are much easier to use if you can read Indonesian. Used book stores will sometimes have useful material. Some tourist shops will have a one or two specimens for sale, at bargaining prices, of course. Open air street markets may also have a table or a blanket with some rocks, minerals or fossils for sale. During 1994, at the Pasar Rawa Bening, East Jakarta a gem and mineral market started to develop selling polished amethyst, petrified wood, agate, and minerals. This area after more than 20 years has become quite significant, but not particularly for mineral specimens.

Just crystallized sulfur being sold at the Tankuban Perahu volcano crater, Bandung, West Java, August 1989 with Scott Bird, a Chevron geologist..

Calcite, Grasberg mine, PT Freeport Indonesia, Sudiman Mountain Range, Irian Jaya, obtained 1994, 5 inches across.
Specimen from David Potter.

Some national parks, like the Tangkuban Perahu volcano, south of Bandung, Java will have a table with freshly formed sulphur crystals as well as cooking eggs for tourists in the active fumaroles. Slightly older volcanics harbor petrified wood, agate, chalcedony, quartz veins, and amethyst. These may show up in a provincial museum. The most common material for sale or display are various forms of chalcedony with amethyst from Kalimantan, Java or Sumatra next most common. The area south of Sukabumi, West Java is known for its petrified wood and sometimes vein quartz crystals. Shops in town will have some polished chalcedony masses. Street markets in Banjar Masin, Kalimantan have in the past had alluvial diamonds for sale, found upriver. Alluvial, placer gold might be possible to find for sale, but its provenance may be debatable.

Intrusive volcanics reveal alpha quartz crystals and perhaps feldspar phenocrysts. One locality, a dacite outcrop, in southwest Java has an abundance of alpha quartz up to 1 inch in diameter, loose in road cuts and creek bottoms, having weathered out of the dacite. This locality was found after seeing specimens for sale in town and then inspecting and reading a published geologic map of the area which noted the crystals. Prehnite plates have been collected from Kalimantan were noticed in a small shop in Bandung.

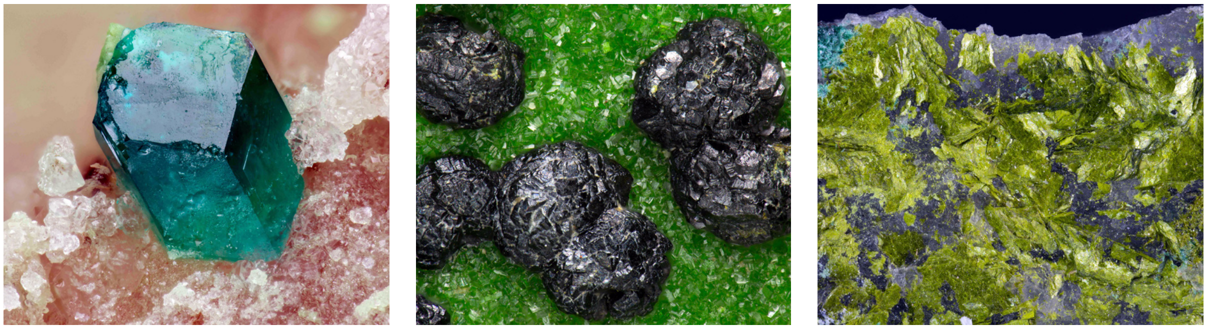
Sedimentary rocks provide quartz, calcite, dolomite, pyrite, marcasite and pyrrhotite. Limestone quarries observed while traveling are always worth inspecting. West Timor has several places along some rivers with calcite-lined open fractures, nodules of pyrite and euhedral pyrrhotite crystals eroded from lignite and shale beds. Timorese minerals and fossils of Paleozoic crinoids and brachiopods or Mesozoic ammonites are usually cheaper but not more common than the island's hand-woven textiles.

The few exposed felsic plutonic rocks in the country are Paleozoic cratonic fragments with pegmatites containing muscovite and rarely beryl. Miarolitic cavities with quartz, feldspar and micas in the Tertiary-aged granites have not been reported from the archipelago but undoubtedly exist.

Mineral and gem collecting will continue but with rare exceptions only limited specimens will reach international markets. The blue-purple grape amethyst chalcedony from around Manakarra Kampung, Mamuju Kebupatan, Sulawesi Island is one rare example. Amethyst crystals form Sumatra and Kalimantan should be more common. Alluvial diamonds from Kalimantan are available on the market. Certainly more surprises should exist.

New discoveries at Copper Hill, Taos County, New Mexico

Ramon S. DeMark, Thomas Katonak, Jesse Kline, and *Virgil W. Lueth*



Dioptase (FOV 2mm); Vesigniete on Conichalcite (FOV 2mm); Volborthite (FOV 9mm). Photos by Michael Michayluk.

Copper Hill lies in the Picuris mining district of Taos County, some two miles north of the well-known Harding mine. The Copper Hill Mining Company first developed the property in 1900 (Lindgren, 1910) and erected a concentration mill. The Champion mine, on the west end of Copper Hill, was developed around a 180-foot shaft and a 60-foot shaft with a 350-foot connecting adit. On the Oxide King claim, a short distance to the south, a 180-foot shaft was sunk. The Wilson mine (prospect) is just east of these workings (Lindgren, 1910). Mineral deposits described by Lindgren consist of veins of glassy quartz carrying copper, silver and gold. Lindgren also reports chalcocite, cuprite, malachite and chrysocolla being present and "it is said that argentite and tetrahedrite also occur".

Williams and Bauer (1995) describe the deposit as a strata-bound copper-silver antimony deposit located near the contact between the early Proterozoic Ortega formation (quartzite) and younger shists (Rinconada formation). Mineralized quartz veins exist at the Champion mine and Wilson prospect. These veins contain clumps containing oxidized copper, iron and antimony oxides along with considerable malachite and chrysocolla staining. Stibiconite, partzite, hematite, cuprite and chalcocite were identified using X-ray diffraction (Williams and Bauer).

A. Locke, et. al. evaluated the property in 1920 and they noted that "(the) local report in Santa Fe is that it was largely a stock-selling scheme." Additionally, "a concentrator was built and burned as soon as a fire insurance policy was issued on it." Locke concluded "the impossibility of the property becoming an important copper producer." During the 2000's the Champion area was leased/operated for production of ornamental rock (Taos News archives) but the patented claim has been dormant since that time.

In 1988, one of the authors (RSD) noted a micaceous, neon-yellow mineral at the Wilson prospect. It was determined that this was volborthite (hydrated copper vanadate) through microprobe analysis (Hlava, pers. comm. 1988). Additionally, in 1980, conichalcite (calcium, copper arsenate), initially reported from Copper Hill by Joe Taggart (DeMark, 1980), was found to be widely occurring in the area. Neither mineral had previously been reported from Copper Hill. In May, 2010, dioptase was found in the Champion mine area. Identification was based on distinctive crystal morphology and color. Only a small number of specimens were recovered.

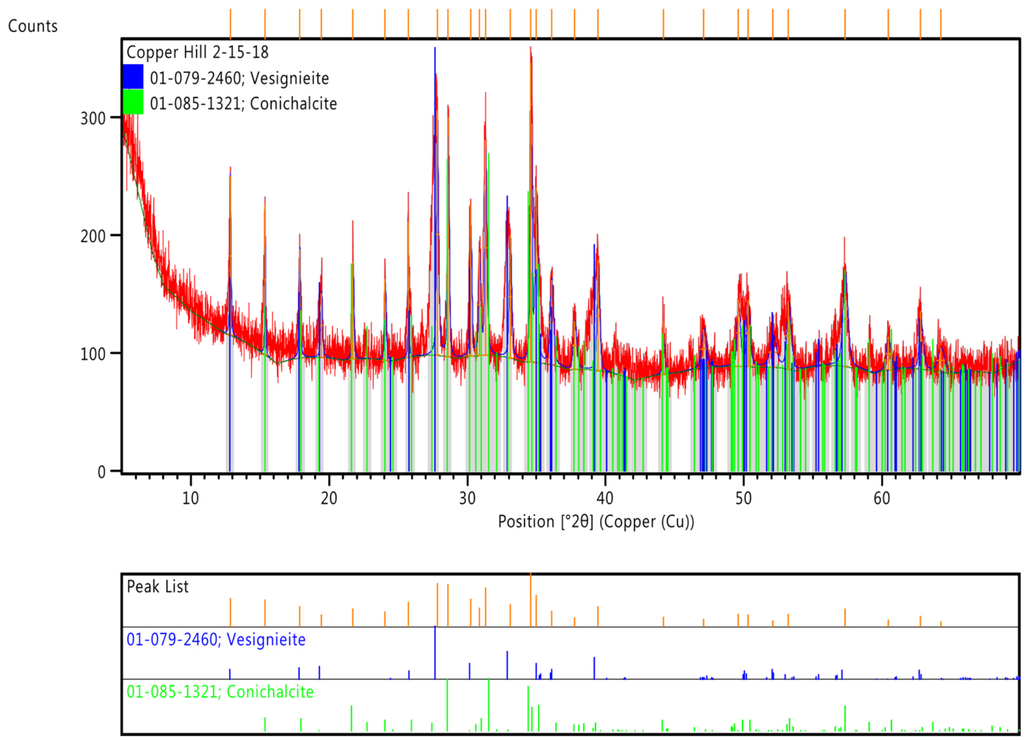


Figure 1. X-ray diffractogram of vesignieite and conichalcite from the Wilson prospect, Copper Hill district, Taos County, NM.

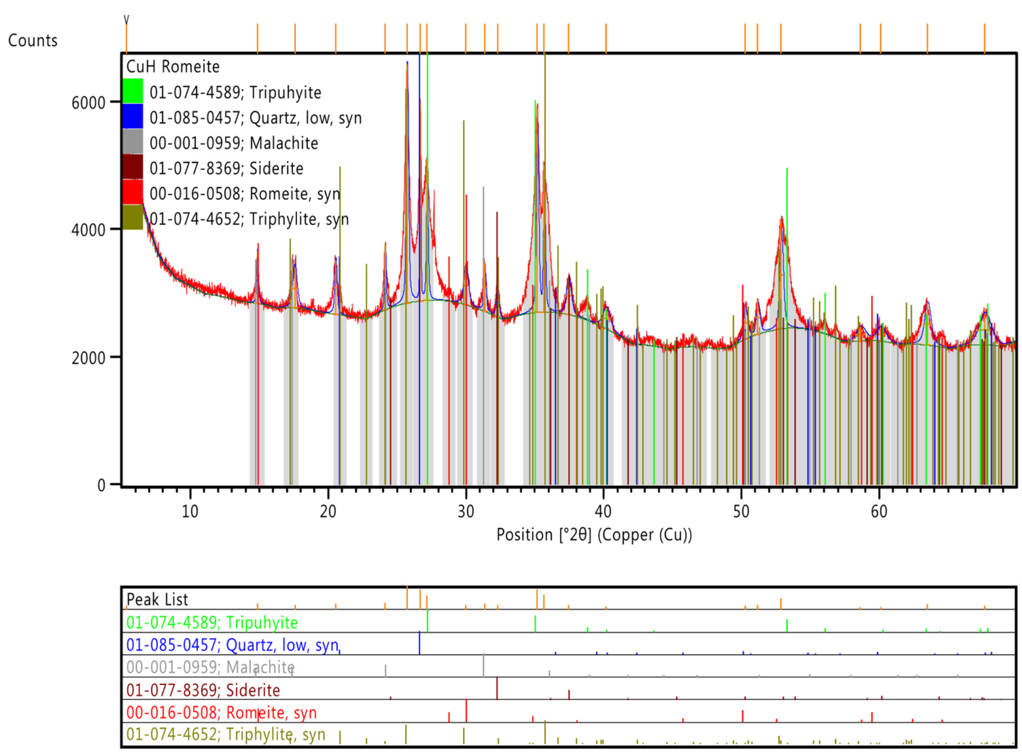


Figure 2. X-ray diffractogram confirming the presence of tripuhyite and possibly romeite at the Wilson prospect, Copper Hill district, Taos County, NM.

A visit to the Wilson prospect in early spring 2018 turned up what appeared to be a sub-metallic black mineral in association with conichalcite. Spherical crystalline aggregates (about .5mm) were found in a very few specimens. X-ray diffraction (Figure 1 page 13) determined that this mineral was vesignieite (barium copper vanadate) and that, in fact, it was a dark green. The mineral closely resembles specimens from the Mashamba West mine, Democratic Republic of the Congo (Mindat). This is a first occurrence of this mineral in New Mexico.

Clumps of the anhedral greenish vein material in the quartz veins at the Wilson prospect also aroused curiosity. This material has a box-work structure suggesting that it may have been altered from some other mineral. X-ray diffraction analysis (Figure 22 page 13) determined the mineral to be tripuhyite (an iron antimony oxide); possibly an alteration product of tetrahedrite. Tetrahedrite had been reported, but not identified, from Copper Hill (Lindgren, 1910).

The eastern portion of Copper Hill and the Wilson prospect are on BLM public land but a strip of private land must be crossed to reach the area. The locality has been withdrawn from mineral claims since 2000. The western portion of Copper Hill and the Champion mine are on private property and permission must be obtained prior to entry.

References

DeMark, R.S., 1980, The Red Cloud mines, Gallinas mountains, New Mexico, The Mineralogical Record, 11:69-72.

Lindgren, W., Graton, L.C. and Gordon, C.H., 1910, The ore deposits of New Mexico, U.S. Geological Survey Professional Paper 68, 351 pp.

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Schilling, J.H., 1960, Mineral Resources of Taos County, New Mexico, NMBGMR Bull. 71, 124 pp.

Williams, M.L., and Bauer, P.W., 1995, The Copper Hill Cu-Ag-Sb Deposit, Picuris Range, New Mexico: Retrograde Mineralization in a Brittle-Ductile Trap, Econ. Geology, 90: 1994-2005.

Mindat.org

Mineral occurances at the Copper Hill Mining District	
Andalusite	**Kayanite**
Agentite	**Malachite**
Azurite	**Muscovite**
Brochantite	**Opal**
Chalcocite	Partzite
Chloritoid	**Polylithionite**
Chrysocolla	Pyrite
Conichalcite	**Quartz**
Cordierite	**Sericite**
Corundum	Sillimanite
Covellite	**Staurolite**
Cuprite	Stibiconite
Dioptase	Tetrahedrite
Fluorite	Tourmaline
Garnet	**Tripuhyite**
Gold	**Vesignieite**
Hematite	**Volborthite**
Kaolinite	**Wollastonite**

Mineral species verified on-site (see bold fonts).

Updated mineral lists: Atwood Hill area, Hidalgo County, New Mexico

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The Atwood Hill Area is located 1.5 miles south of Interstate Highway 10 from Lordsburg, Hidalgo County, New Mexico. Access is south from Shakespeare Road and west from County Road 494 via dirt road just south of the Cemetery. The southern portion of the Lordsburg Mining District produced copper and lesser amounts of lead, zinc, silver and gold starting in the late 1800's. The mines in the vicinity of Atwood Hill, now inactive, are examined, online species listed and updated as to new species for each locality:

Ludjibaite on Quartz, Atwood Mine, Atwood Hill, Lordsburg District, Hidalgo County, New Mexico.

Atwood Mine:

Online Species Listed: Azurite, brochantite, calcite, cerussite, chalcopyrite, chrysocolla, covellite, galena, goethite, hematite, malachite, olivenite, pyromorphite, pyrite, quartz, wulfenite.
New Species for Locality: Aheylite, apatite sp., barite, birnessite, cuprite, corkite, dickite, fluorophlogopite, gormanite, hydroxylpyromorphite, kryzhanovskite, ludjibaite, muscovite, opal v. hyalite, scholzite, strengite.

General Jerry Boyle Mine:

Online Species Listed: None.
New Species for Locality: Aheylite, apatite sp., azurite, barite, calcite, cerussite, chalcopyrite, chrysocolla, covellite, fluorite, galena, goethite, ludjibaite, malachite, olivenite, pseudomalachite, quartz, scholzite, sphalerite.

Hidalgo Copper Company Mine:

Online Species Listed: None.
New Species for Locality: Azurite, barite, bornite, chalcopyrite, corkite, goethite, leadhillite, ludjibaite, malachite, pseudomalachite, pyromorphite, quartz.

Pole Line Prospect:

Online Species Listed: Barite, cerussite, wulfenite.
New Species for Locality: Anglesite, arsenopyrite,
azurite, calcite, cacoxenite, chalcopyrite, fluorcalciopyrochlore, galena, goethite, gypsum, malachite, mimetite, quartz, strengite.

Pole Line Prospect, West:

Online Species Listed: None.
New Species for Locality: Calcite, Cerussite, chalcopyrite, chrysocolla, galena, goethite, gold, malachite, quartz, wulfenite.

For the most part, the collected materials from the Atwood Hill Area fit the micromount, thumbnail and small cabinet category. Some species available are rare and qualify as the first occurrence for New Mexico as shown below:

First locality for New Mexico and the USA		
MINERAL	**NEW MEXICO**	**U.S.A.**
Ludjibaite	X	X
Fluorcalciopyrochlore	X	X
Aheylite	X	X
Hydroxylpyromorphite	X	
Fuorophlogopite	X	
Gormanite	X	
Scholzite	X	
Kryzhanovskite	X	
Leadhillite	X	

Seven unknowns from the Atwood Hill Area remain unanalyzed. These are in the process of being tested via XRD.

Access and collecting opportunities are mostly good. The Atwood and General Jerry Boyle mines are patented mining claims and are private property. However, they are open at present without signage. Existing unpaved roads requiring high clearance vehicles will take you to the vicinity of each localitiy. The remaining localities are apparently on public lands, but should always be checked for active mining claims before collecting.

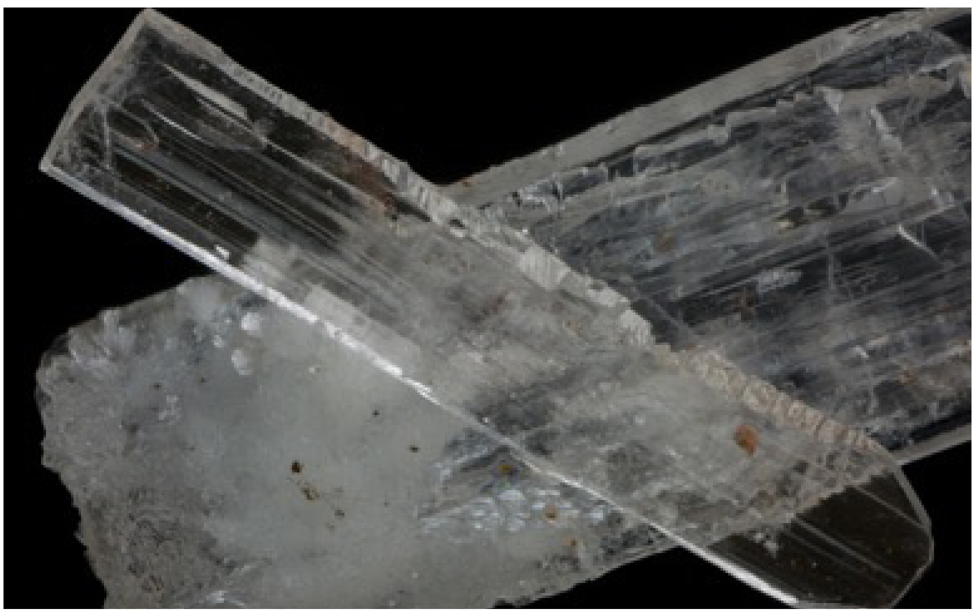
Reference

Lasky, Samuel Grossman, 1938, Geology and Ore Deposits of The Lordsburg Mining District, Hidalgo County, New Mexico, USGS Bulletin 885.

Minerals of the Torpedo–Bennett fault zone
Organ Mountains, Doña Ana County, New Mexico

Michael C. Michayluk

The Organ Mountains in Southern New Mexico are host to a rich assemblage of minerals and many metallic ore deposits. A particularly rich trend of mineralization occurs in the northern part of the range along a series of faults called the Torpedo-Bennett fault zone. Copper porphyry-type deposits at the Torpedo mine in the northern reaches of the fault zone generated copper-zinc skarns immediately adjacent to the porphyry system (Lueth and McLemore 1998). One such skarn was mined for Cu at the Memphis Mine, just adjacent to the Torpedo. An outward trend continues along the faults from the porphyry and skarn, followed by Pb-Zn-Ag replacement deposits (Lueth and McLemore 1998). The Stevenson-Bennett mine is a historically significant mine probably most famous for its exceptional wulfenite specimens, and is an example of this type of Pb-Zn-Ag replacement mineralization within the fault zone. Both the ore minerals and gangue minerals will be described in depth from each of the three deposits, the Torpedo, the Memphis, and the Stevenson–Bennett.



A doubly terminated hemimorphite crystal; Stevenson-Bennett Mine FOV about 8.5mm.

List of minerals from the Torpedo Mine	
Acanthite	Hemimorphite
Azurite	Kaolinite
Brochantite	Malachite
Chalcocite	Pyrite
Chalcopyrite	Quartz
Chrysocolla	Rosasite
Copper	Smithsonite
Cuprite	Turquoise
Gypsum	

The next two tables are on the following page.

List of minerals from the Memphis Mine			
Adamite	Chalcopyrite	Galenobismutite	Rosasite
Andradite	Chrysocolla	Goethite	Scheelite
Aragonite	Conichalcite	Hematite	Smithsonite
Aurichalcite	Copper	Hemimorphite	Sphalerite
Azurite	Covellite	Hetaerolite	Sulphur
Baryte	Cuprite	Jarosite	Tetradymite
Bismuthinite	Diopside	Limonite	Vanadinite
Bismutite	Dolomite	Linarite	Willemite
Brochantite	Dyscrasite?	Malachite	Wollastonite
Calcite	Epidote	Massicot	Wulfenite
Cerussite	Fluorite	Pyrite	
Chalcocite	Galena	Quartz	

List of minerals from the Stevenson-Bennett Mine	
Adamite	Hydroniumjarosite
Anglesite	Jarosite
Aragonite	Limonite
Aurichalcite	Linarite
Beudantite Group	Malachite
Brochantite	Mimetite
Calcite	Mottramite
Caledonite	Phosgenite
Cerussite	Plumbojarosite
Cesarolite	Pyrite
Chlorargyrite	Pyromorphite
Chrysocolla	Quartz
Descloizite	Rosasite
Dolomite	Siderite
Duftite	Silver
Fluorite	Smithsonite
Galena	Sphalerite
Goethite	Stengite
Gypsum	Vanadinite
Hematite	Willemite
Hemimorphite	Wulfenite

Capillitas Mine
Catamarca Province, Argentina
"The other Rhodochrosite locality"

David Stoudt, Santa Fe, New Mexico

Argentina is known for it's imposing scenery and landscapes from southern-most glaciers to high altiplano deserts. All people marvel at majestic mountains and thundering waterfalls. Commercial mining deposits, oil and gas fields are under active development. For travelers, world-class beef and wine can be had. It can be a mineral and fossil collector's paradise with limited interest from the local population. Collector's number less than 200 in a population of over 37 million. But traveler, be aware; this can be some of the most desolate landscape and sometimes forbidding adventures.

The author has been fortunate in a professional geological career to have worked in over 37 countries. He has lived in three countries as an American ex-pat. Argentina was one of those countries where he could drive his vocation as an oil/gas geologist and avocation of mineral collecting. Two industry icons have aided his adventures.

Capillitas Mine, Catamarca Province, northwestern Argentina has been known as a complex gold and copper mineral bearing deposit for over 500 years. The mine dates to the days of the Incas and Spanish conquistadors. The author attempts a comprehensive understanding of the complex geology and mineralogy of what some call a South American, "enigma." The discovery of the Capillita "stalactite cavern" in November 1986, lead to one of the Argentina national disgraces when one cavern, measuring 15 m (49 ft) in width and 6 m (20 ft) in height, was destroyed on orders by the Argentine Federal and Military government. Saadi (1991) documented the cavern with some of the few known photographs which will be shown in the presentation. It is known as the "Argentine Day of Infamy."

Left–Rhodochrosite: Capillitas Argentina (36cm x 20cm, Stoudt, 2006). Right–Rhodochrosite, Pyrite: Capillitas Argentina (Hand cobbled, Stoudt, 2006).

Capillitas is found on the western boundary of Argentina and on the eastern margin of the conveyor-belt style, Pacific oceanic plate. At Capillitas, 5 to 9 million-year-old Miocene volcanics intrude and pierce 400 million to 1 billion-year-old granites and hard rock basement from Ordovician to Pre-Cambrian in age. Nineteen (19) known rhodochrosite veins up to 600 m (1,968 ft) in length are found in both the intrusive volcanics and the granite basement. The volcanic intrusive neck measures approximately 1,500 m (4,920 ft) in width and at an elevation of 3,100/3,300 m (10,168/10,824 ft) above Sea Level. Current estimate is that 20 kms (12 mi) of underground workings are present. Spectacular banded and stalactitic-form rhodochrosite has been mined for over 50 years. Rhodochrosite mined prior, was thrown on the dumps as waste. Today mining at Capillitas has not changed much from decades ago, still hand cobbling. Production volumes of any the base minerals are unreliable as the mine has changed ownership numerous times with fraud and corruption by both ownership and local/ national government.

Rhodochrosite stalactite cavern discovered November 1986. Destroyed on orders of Argentine Military and Federal government ("Argentine Day of Infamy"). Interlocking series of small caverns measuring a total of 15 m width (50 ft) by 6 m height (20 ft). Stalactite diameters up to 45 cm (1.5 ft). Photo covers 4.5 m (15 ft) in height by 2.5 m (8 ft) in width.*Photographed by J.A. Saadi, January 1987.*

Capillitas mineralogy has been estimated at 120 mineral species by Mindat.org (2018) and at 150 species by Putz, et al. (2009). The later work was an Argentine sponsored survey of the mine. Primary minerals include pyrite, enargite, gold, tetrahedrite, sphalerite, chalcopyrite, galena, bornite, chalcocite, in paragenesis order. A bornite/ chalcocite stock measuring up to 200 m (656 ft) in diameter was mined in the distant past. Wire-gold was recently found in a boulder on the mine flank. Secondary minerals are covellite, anglesite, gypsum, malachite, azurite, cerussite, cuprite, pyrolusite, realgar, orpiment, chalcanthite, dioptase and copper. Rhodochrosiite and capellite (combination of rhodochrosite, smithsonite and siderite), quartz and barite are considered gangue. The presentation will focus on subsurface vein and mine workings and rhodochrosite from private collections. Many of the primary and secondary minerals are very poorly documented in photographs and collections. Specimens went undocumented from the ancient workings and Argentine museums lack representation.

Capillitas rhodochrosite (manganese carbonate) occurs in both the volcanics and the granite. There is abundant manganese in the adjacent bedrock in the form of pyrolusite veins. The "enigma" occurs when considering there are no carbonate (limestone and dolomite) host rocks existing within 200 miles of Capillitas. In a comparison of Bisbee minerals which many collectors from the symposium probably have in their collections, Bisbee had carbonate caverns/spelothems formations overlying the primary ore bodies (Graeme, et. al, 2016). Bisbee has meteoric-surface water influence and deep subsurface mineral laden fluid influence. Capillitas rhodochrosite or manganese carbonate could only have come from deep seated, subsurface carbonate laden fluids. So meteoric waters in normal cave formation probably did not occur at Capillitas. Today, 40 miles away from Capillitas occur carbonate-rich hot springs which look like miniature Yellowstone Mammoth Hot Springs. The present may be the key to the past (Lyell, Principles of Geology, 1830). Various researchers have labelled Capillitas as: 1) Epithermal formation as deposited from warm water at shallow depths or 2) Hydrothermal formation under high temperature and high pressure.

Many dazzling specimens of Capilltas rhodochrosite are found around the world. However, the best from Argentine seldom leave the country.

The author would like to thank Virgil Lueth (Socorro) for accepting a distant mineral deposit for this Southwest symposium; Kelsey McNamara (Socorro) for publication requests beyond the call of duty; Charles Dalton (Denver) for presentation review; Edurado Jawerbaum (Argentina) for collecting fellowship and road adventures and Susan Hoffman, my wife (Santa Fe) for putting up with a globe-trotting geologist and mineral collector.

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Mineralogy of the Santa Eulalia Mining District, Chihuahua, Mexico

Peter K.M. Megaw

Cerussite on aurichalcite, San Antonio Mine, 8th Level, 3 cm.

The Santa Eulalia Mining District lies in central Chihuahua, Mexico about 360 km south of El Paso, Texas and 23 km east of Chihuahua City. Santa Eulalia has been in nearly continuous production for over three centuries (1703–present) and ranks as one of Mexico's chief silver and base metal producers: over a half billion troy ounces of silver and nearly 6 million tonnes of lead and zinc have been recovered from her mines. In a regional geological and mineralogical perspective, Santa Eulalia is the largest of a family of distinctive intrusion-related ore deposits hosted in limestone and dolomite called "Carbonate Replacement Deposits" that occur in a 2,200-km-long belt running from Hidalgo State to the Chihuahua–U.S.A. border and into the USA. This belt of deposits includes many of Mexico's most prolific specimen-producing districts such as: Mapimi (Ojuela), Naica, Concepcion del Oro, Los Lamentos, San Carlos, San Pedro Corralitos, Charcas and Sabinas–San Martin. That these deposits are prolific specimen producers stems from aspects of their primary genesis and subsequent oxidation that create abundant open space during times when potential for crystal growth is high. Additionally, the largest Carbonate Replacement Deposits characteristically undergo multiple stages or pulses of mineralization and oxidation, which results in mineralogical overprinting and the creation of a wide range of mineral species and pseudomorphs. Santa Eulalia's large size, multi-stage genesis and deeply penetrating oxidation make her especially well-endowed in this regard.

The mining district is divided into the West and East Camps, based on a combination of geography, production and style of mineralization. The West Camp lies on the western flank of the range and is characterized by massive sulfide manto and chimney orebodies with local,

Legrandite on gypsum, Inglaterra Mine, 2nd Level 5 cm wide.

Wulfenite, Buena Tierra Mine 13th Level, 6 cm wide.

high-level iron-calcic skarns. The East Camp ("Campo Oriente" a.k.a. the San Antonio mine area) lies on the eastern fringe of the range and is characterized by bilaterally symmetrically zoned, intrusion-cored skarns with peripheral massive sulfide manto bodies. The 2.5 km wide intervening zone, known as the Middle Camp, contains minor mineralization and saw only limited production. The ultimate source of the district mineralization is actively being sought but remains elusive.

The earliest mining at Santa Eulalia focused on extensive near-surface oxidized orebodies dominantly composed of cerussite and anglesite laced with silver halides. These were very high grade and were diligently followed downwards from the surface until water and/or sulfides were encountered. The West Camp mines are all above the water table, but oxidation extends

Pyrite ps Pyrrhotite, Inglaterra Mine, 3rd Level 14 cm tall.

erratically from 150 to 750 m depth depending on whether the Capping Series volcanic rocks were thick enough to prevent infiltration of surface waters. Because of this, oxide-ore workings terminated against sulfides on different levels in separate but adjoining mines. In contrast, in the San Antonio Mine the water table is quite high, sub-horizontal and well-defined, lying at the 8th Level of the mine, approximately 400 m below the surface. Because nothing impeded groundwater infiltration there, ores are almost completely oxidized down to the water table where an unusually well-developed body of supergene zinc mineralization exists. Pristine sulfides extend below this to the bottom of the mine. The development of selective flotation in the early 20th century allowed exploitation of the by-passed sulfide ores composed of galena; sphalerite and pyrrhotite, which became the backbone of district production to the present. These ores were followed from the base of oxidation to depths of over 1,200 m below the surface. Active mining continues in the East Camp, but the West Camp is largely mothballed and the deepest levels are gradually filling with water; the water level currently has reached the 18th Level.

Tons of superb mineral specimens, ranging from individual microminerals to the contents of entire caverns, have been recovered from Santa Eulalia's labyrinthine mines, primarily during the last 100 years. Few private and museum collections and probably even fewer dealer stocks lack specimens from the district. At present, approximately 200 mineral species have been identified from the district and although no species unique to the district have been found (yet!), Santa Eulalia has yielded some of the world's finest specimens of calcite, creedite, gypsum, hemimorphite, ludlamite, mimetite, natanite, pyrrhotite, rhodochrosite and smithsonite. Although specimen production volume is down from the middle of the last century, important finds continue to be made almost annually and the prospects for continued production are excellent.

Arizona pseudomorphs

Barbara L. Muntyan

Pseudomorphs (Latin for “false form”) are a varied and interesting group of mineral specimens appreciated by many collectors. Arizona has many localities which have produced pseudomorphs. The most common are the result of alteration in carbonate deposits—azurite to malachite or chrysocholla. Indeed, virtually all of the porphyry copper deposits in the State have produced noteworthy examples of pseudomorphs. Perhaps the best-known are the “Roman sword” malachite after azurite clusters from several mines in Bisbee, notably the Junction and the Cole. A close second are the velvet malachite pseudo-rhombic crystals on tenorite matrix from the New Cornelia mine in Ajo. But there are also numerous examples of azurite altering to malachite from Morenci, from the Silver Hill mine, and many other locales throughout the state. Chrysocolla pseudomorphs after azurite or malachite are also found in copper deposits in Arizona. Some of the best have been found in the oxide zone at Bagdad as the open pit was being developed. These specimens are after azurite crystals up to 4" in length. Excellent examples of chrysocolla after malachite or azurite are also found in Globe-Miami, especially from the Old Dominion mine.

Gypsum replacing Glauberite, Camp Verde, Arizona.

Alteration pseudomorphs can be found in many granitic deposits. Sharply defined specimens of limonite after pyrite have been found at the Belmont mine in Washington Camp/Duquesne, at the Fat Jack mine, at the Willow Springs locale, and many other locales around the State. The Willow Springs deposit is also well-known for alteration of schorl crystals to micaceous pseudomorphs, some to six inches in length. Some pseudomorphs after pyrite are not limonitic, but rather are hisingerite (iron silicate). Testing has been done at the University of Arizona using RAMAN analysis; casual field observation by the author suggests that hisingerite is fairly common throughout Arizona and is often mistakenly identified as limonite.

Pseudomorphs can form as a result of other processes. Perhaps the best-known and most prolific locality is the salt mine near Camp Verde, AZ, which has produced replacement pseudomorhs of selenite and glauberite. These have formed crystals up to three-inch monoclinic crystals in cream, milk-white, tan, or grey color as single, sharp crystals or clusters without matrix.

Quartz over Malachite and Chrysocolla, Live Oak Pit, Old Dominion mine, Globe, Arizona.

Quartz after calcite, South Comobabi Mountains, Pima County, Arizona.

Chrysocolla, Pearl Handle Pit, Ray mine, Arizona. Flagg Mineral Foundation specimen

Arizona also boasts a wide selection of encrustation pseudomorphs, or "epimorphs." Some purists do not recognize these as true pseudomorphs because they do not fit the classical definition of a pseudomorph, namely a molecule-by-molecule replacement of one mineral by another, exactly filling the same volume as the original crystal. Encrustation pseudomorphs are more like icing on a cake: taking the form of the underlying material but being slightly larger than the original. Quartz perimorphs are found in a number of localities in Arizona, with the original crystal form easily identifiable.

One of the finest localities for quartz perimorphs is found in the South Comobabi Mountains in Pima County. Calcite schalenohedra up to four inches tall are replaced by a fine-grained quartz druse coating. Each of the ridges in one area of the South Comobabis has a characteristic appearance of differing quartz pseudomorphs. While most are white or pale amethystine crusts after scalenohedra, white quartz druses after calcite forming sharp rhombs have also been found. Rarely, quartz casts of cubic fluorite, often forming on top of quartz after calcite specimens are also found.

Another important locality for quartz pseudomorphs was a find made in Duquesne on the ridge between the North and South Belmont mines in 2001 by Paul Harter, Gene Schlepp and Jim Bleess. They were looking for Japan-law twins of quartz when they hit a chain of three large, cave-like vugs. While there were a few quartz twins recovered, the really noteworthy find was a series of quartz clusters with quartz and calcite shoveled onto the dump and abandoned. Following directions from Paul Harter, Don Belsher of Colorado and I located the dig and sifted the extensive dumps. We were able to recover over two flats of pseudomorph specimens.

Perhaps the most alluring find of quartz pseudomorphs has been found at the Piedmont Mine in Yavapai County. These are quartz coatings over pseudo-rhombic malachite and azurite specimens. The crystal surfaces range from fine-grained milky quartz to gemmy quartz points over emerald-green, light green-to-whitish, or dark green, large crystals. Although the legend is that these specimens were out of a single pocket, it is fairly clear to any knowledgeable field collector that several vugs produced the variety of specimens. They are an icon of Arizona pseudomorphs, and perhaps the rarest.

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Arizona's love affair with minerals, from prehistory to statehood

Les Presmyk

Long before the Spanish conquistadors entered Arizona, the native peoples mined and fabricated turquoise for cultural and trade purposes. Significant artifacts involving hundreds and thousands of worked pieces in necklaces and figurines have been discovered in various archeological digs over the past 150 years. The extent to which turquoise was traded and moved throughout the southwest U.S. and Mexico from the relatively few sources in Arizona and New Mexico was extensive, adding to the significance of this sky blue mineral.

When the Spanish entered Arizona they were hoping to duplicate their success in finding gold as they did with the Inca in Peru. While there were legends including the Seven Gold cities of Cibola, which turned out to be adobe pueblos, the reality was the indigenous peoples worked turquoise and not gold and silver. Turquoise is a mineral and stone that has been worked and treasured throughout history and not just in the southwest United States and northern Mexico, but throughout the world.

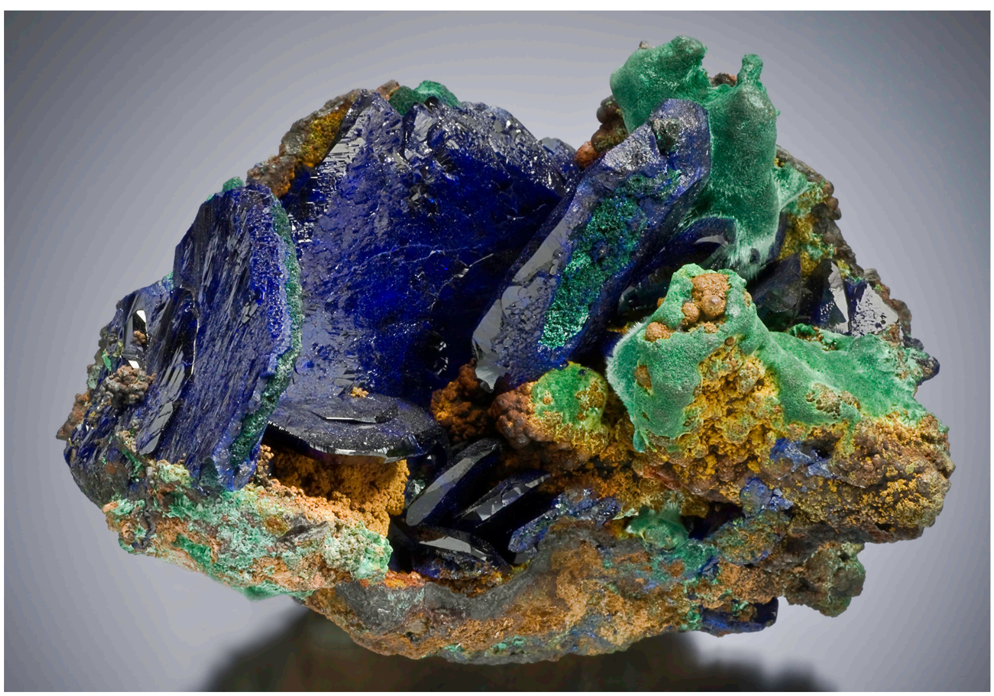
Turquoise pendent, 1.8cm wide from 800 to 1,300 years ago. Discovered near Heber, Arizona. Private collection. *Photo by Jeff Scovil.*

The earliest mining by Americans took place in the southwestern part of Arizona as unsuccessful California gold seekers began returning back east in the early 1850s. The placers of this area produced enough gold to entice prospectors into continued exploration, which took them into central Arizona around what would become Prescott. At the same time, others were exploring and beginning to develop silver and lead deposits in the south central part of the territory around Ruby, Mowry and the Santa Rita Mountains. This was spurred by the part-time activities of the military because they were generally the first ones into an area. Fort Buchanan was established south of Tucson to protect the entire southern area. By the late 1850s collections of rich silver ore samples were being shipped back to St. Louis and other points in the east to attract capital for mine development. Once the Civil War started, all of this development came to an end. When the Army returned in the mid 1870s to subdue the Apache tribes, prospecting and mining resumed. In many cases, it was Army troops who made many of the initial discoveries. The Silver King outcrop was found while building a road from Superior to Globe over the various mountain ranges. The original discovery of Bisbee was actually a lead outcrop. The Stonewall Jackson and Tombstone were actually found by prospectors.

Once these rich silver and gold deposits were discovered, it took significant amounts of capital to develop these mines. The two places where this money could be found was San Francisco and east of the Mississippi. The easiest way to entice people to invest was to show them the prettiest and richest specimens from the mine (hopefully from the mine). There was also what became known as the "Great Diamond Hoax" in which the remoteness of the Colorado Plateau was used to the advantage of the promoters and the supposed discovery of an area rich in diamonds, rubies, sapphires and emeralds, all the more interesting geologically because of the vast amounts of sedimentary rocks comprising this region.

With the advent of geologists and mining engineers bringing an air of legitimacy to the mines in Arizona, they also brought an interest in documenting and preserving specimens. Silvers from the Silver King and the Stonewall Jackson mine started to show up in dealers' inventories in the east. By the mid-1880s, the copper mines of Bisbee and Morenci were encountering large pockets and even caverns lined with azurite and malachite, the likes of which had not been seen since the mines at Chessy, France five decades earlier. Especially at Bisbee, collecting became a part of the culture, from the mine owners and general managers, to the miners and supervisors. At the same time mineral dealers were starting to travel to the area to look for inventory, numerous collections were being started in Bisbee. These mineral specimens would be collected by mine management for their beauty and economics. After all, a hundred pounds of azurite and malachite specimens were worth less than $5.00 if refined into copper but worth multiple times that if sold for specimens. In addition, James Douglass and

Pyrite and Quartz, Groom Creek, Arizona. From the territorial governor's collection, probably collected around 1875. Les and Paula Presmyk collection. *Photo by Les Presmyk.*



Azurite and Malachite after azurite, Czar Mine, Bisbee, Arizona. Les and Paula Presmyk collection. *Photo by Jeff Scovil.*

Ben Williams assembled collections and provided specimens to many of the original stockholders in the Copper Queen Consolidated Mining Company. In several cases, the Copper Queen Consolidated Mining Company displayed this beautiful mineral wealth at eastern expositions to promote Arizona's quest for statehood. In addition to the tremendous wealth generated by the copper mines, the culture and heritage of collecting would become part of Bisbee's legacy to the state. And, when some of the caverns were encountered they hosted Masonic Lodge conventions and even high school graduations.

Transportation around the state was mainly by horseback and stagecoach, so in some respects it is amazing anything was collected and survived. Today, the trip to the Red Cloud Mine and the surrounding Silver District takes about an hour from Yuma, assuming the road is fairly decent shape. In 1880, it would have taken more than a week by horseback or by boat up the Colorado River to the millsite and then inland for a few miles. And let us not forget this area is so desolate once one leaves the Colorado River, areas were used in training Apollo astronauts for moon landings. In spite of all this, the beauty of the wulfenite from the Red Cloud (and collector markets in the East) was enough to overcome these obstacles and specimens found their way into dealers' inventories and ultimately collections and museums.

Silver specimens were saved at the Silver King, the Stonewall Jackson and even Tombstone. By 1905, the low-grade copper ores around Miami (5% copper or so) were being examined and by 1910 were being mined. As at the Old Dominion mine in Globe, the Live Oak mine was predominantly copper oxides and besides azurite and malachite, chrysocolla and drusy quartz on chrysocolla were encountered. The mining methods allowed the mine to operate profitably and additional specimens and cutting material began to be recovered.

Through statehood in 1912, virtually all of the mining was accomplished in the rich underground deposits, which allowed for innumerable opportunities for specimens to be encountered and preserved. In addition to their beauty, they were a means by which the miners could supplement their incomes. Eastern dealers either had agents in the more prolific producing mining camps or ventured west occasionally on purchasing trips. As collectors we need to be thankful that market economics were strong enough to cause specimens to be preserved. Otherwise, we would be dependent on the occasional drawing or description to satisfy our appetites about what came from a particular mine. This is a legacy and fascination that continues to today.

Micromineraleering in the 79

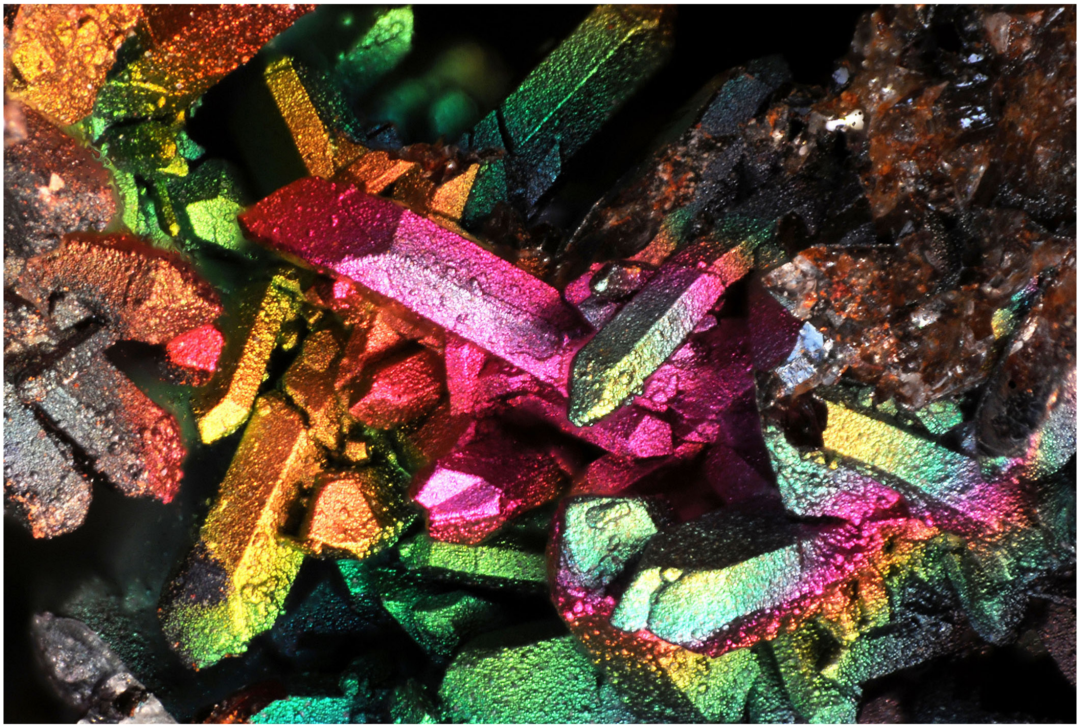
Ron Gibbs

Aurichalcite on wulfenite with hemimorphite, 8 mm field of view, from the 79 Mine, Arizona.

The 79 Mine has produced some of Arizona's best specimens of several species and is well known worldwide for the beautiful minerals it has produced. The mine is currently under private ownership and collecting for specimens continues.

The mine is located in the Dripping Spring Mountains about two hours northwest of Tucson. Other famous localities are close by; the Christmas mine and the Ray mine. Claims were originally staked in 1879 but serious work did not begin until 1919. The Seventy-Nine Mining Company began operations with a 50 ton/day mill but their operations ceased after a few years. Ownership squabbles led to reorganization and the Seventy-Nine Lead-Copper Company began operating in 1928. They operated until 1930, shipped over 2,500 tons of oxidized lead ore and were ranked as Arizona's 5th largest lead producer. Limited mining resumed with a new concentrator from 1936 until 1938 but then closed due to low commodity prices. Production resumed in 1940 by the Shattuck-Denn Mining Corporation which began mining sulfides and extended mine development down to the 7th level. Production ceased in 1949 and little production has occurred since as the mine went through ownership changes and several leasors. More recently, the mine has been operated for specimens by several individuals and groups.

Orebodies in the mine are found within Pennsylvanian shales and limestones of the Naco formation which rest unconformably upon the Escabrosa limestone of Mississippian age. Rhyolite dikes intruded these rocks in the early Tertiary producing garnetized skarns. Mineralizing solutions emplaced sulfide minerals in favorable sediments along dike margins, in brecciated rocks and in fractures and faults. The orebodeies were formed as bedded and vein replacement. Regional uplift and erosion exposed the rocks to weathering producing the oxide minerals so eagerly sought by the mineral collector.



Iridescent hematite, 7mm field of view, from the 79 Mine, Arizona.

The 79 Mine is well known for the outstanding specimens of aurichalcite, hemimorphite, smithsonite and wulfenite that have been collected over many years. High quality miniatures and cabinet specimens grace many private and public collections. Wendell Wilson reported a major find of world-class aurichalcite in 1972. George Stevens, George Brunel, Mitch Dale, and Malcolm Alder collected exceptional specimens of botroiydal green (cuprian) smithsonite from the lower 4th level or "chrysocolla room" in the 1990s. In the early 2000s, George Godas and John Callahan were able to extend further into the aurichalcite zone and recover additional specimens. They also pursued the lower 4th level smithsonite zone further, recovering additional cuprian smithsonite. Godas and Callahan collected hemimorphite from several mine locations and some very nice wulfenite specimens from the 4th level wulfenite stope. These crystals are hard to collect due to their fragility and the hard matrix they are attached to.

There is also a larger suite of minerals that although are smaller in stature are just as beautiful. These microminerals include species that seldom form large crystals, some that are rare, and some more common ones that exhibit a wide diversity of habits and colors. This presentation will highlight many of these "overlooked" minerals to portray the wider mineral diversity found in the 79 Mine.

The following list of minerals known to occur at the 79 Mine comes from many sources but doubtful occurrences and ill-defined minerals with duplicate names have been omitted. Some reported minerals have not been encountered by the author or recent collectors. Several species were encountered in the lower levels of the mine, the 5th, 6th, and 7th levels. However, these levels have been inaccessible for several years and these occurrences cannot be verified.

Reported minerals from the 79 Mine			
Acanthite	Cuprite	Linarite	Scheelite
Andradite	Descloizite	Magnetite	Scorodite
Anglesite	Diopside	Malachite	Siderite
Antlerite	Dioptase	Manganite	Silver
Aurichalcite	Dolomite	Melanterite	Smithsonite
Austenite	Epidote	Mimetite	Sphalerite
Azurite	Fornacite	Molybdenite	Stolzite
Beaverite-Cu	Galena	Montmorillonite	Sulphur
Brochantite	Goethite	Mottramite	Tenorite
Calcite	Gypsum	Murdochite	Tetrahedrite
Caledonite	Halite	Muscovite	Tremolite
Celestine	Halotrichite	Olivenite	Tsumebite
Cerussite	Hematit	Osarizawaite	Vanadinite
Chalcanthite	Hemimorphite	Phosphohedyphane	Phosphohedyphane
Chalcoalumite	Heterolite	Plattnerite	Willemite
Chalcocite	Hollandite	Plumbojarosite	Wulfenite
Chalcopyrite	Hydrozincite	Psilomelane	Zoisite
Chlorargyrite	Jarosite	Pyrite	
Chrysocolla	Kaolinite	Pyrolusite	
Clinoclase	Ktenasite	Pyromorphite	
Clinozoisite	Kuksite	Quartz	
Copper	Lepidocrocite	Ramsbeckite	
Corkite	Libethenite	Rosasite	
Covellite	Limonite	Sauconite	

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Light sensitive minerals

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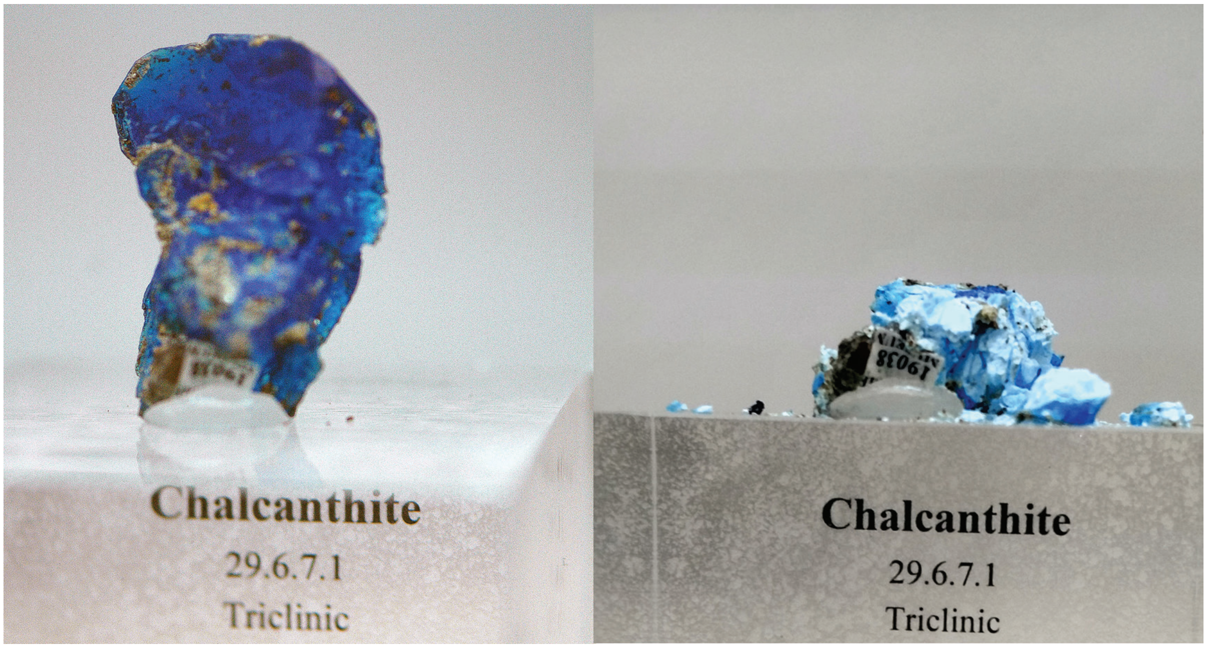
Light induced changes to mineral specimens have been recognized probably since the first proustite crystals were extracted from the ground and brought to the surface. Rapid color change in certain silver halide minerals is the basis of film photography. Close to home, New Mexico collectors are familiar with the rapid fading of blue fluorite specimens from various localities upon exposure to sunlight. This presentation explores the causes of color and presents possible techniques to mitigate or prevent specimen degradation from light exposure.

Twenty centimeter fluorite specimen from the Nakaye Mine, Sierra Co., NM. Photograph on left taken soon after acquisition in 2001, purple slightly enhanced due to fluorescence of film photography. Photograph on the right taken in 2012 after 11 years on display under filtered fluorescent bulbs. *Jeff Scovil photos.*

The seminal paper on light sensitive minerals was published in 1992 by Kurt Nassau. In that paper, he identified 35 light-induced color changes, 8 light-induced decompositions, and 78 light accelerated surface reactions. These changes he related to the 15 physical and chemical causes of color. A survey of the current internet reports of light sensitive minerals has expanded the list, but the causes remain the same. A few particular causes of color are more susceptible to alterations, especially those associated with color centers F (*Farbe*)-centers. The simplest example occurs in halite, sylvite or fluorite where one of the halide atoms is missing and the site is occupied by a single electron. When irradiated by natural sources, this single electron gets displaced and an F-center forms producing color that is normally not present. When external energy (heat or light) is applied to minerals with F-center coloration, the F-center can be removed and thus color disappears. F-centers also occur in quartz where Al3+ causes smoky coloration with radiation and Fe3+ where it initially causes orange and grades to purple. Other light sensitive color alterations occur in minerals with transition metal impurity valence charges in the ligand field (many gemstones) or through charge transfer (blue sapphire, lapis lazuli) and most biologic dyes.

One of the best ways to protect your collection from color induced degradation is to not collect sensitive minerals at all. But, if you insist on ignoring abstinence, there are a number of steps one can take to minimize light effects. Keeping specimens from light, stored in boxes or drawers, with only occasional visits to the lighted world is one option. Moderating or changing light sources is another option. Sunlight seems to be the greatest source of damage with lesser effects from specific types of light sources. Filters are another option; even a plain



Five centimeter tall chalcanthite crystal when placed initially on display in 2015 and current view of the specimen in 2018.

glass window lessens the damaging factor of sunlight by two thirds while specialized filters can do even more. It is also important to store specimens away from reactive partners, e.g. sulfur and silver.

Another important contribution that collectors can make to curatorial science is to photo-document your collections over time. A photograph upon acquisition followed by annual to biannual sessions may help you recognize degradation in your specimen before it becomes too significant. It may also help identify light sensitive changes in minerals heretofore unrecognized and allow for the development or institution of mitigation procedures to save their colors before they are "too far gone."

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Australopithecus to Mindat—Mineralogy through the Ages

Nathalie N. Brandes and *Paul T. Brandes*

The study of minerals has a long, colourful history. As early as 3.39 Ma, *Australopithecus afarensis* were using stone tools. While not a scientific study, these early hominins were making observations about different rocks and minerals to determine which would make the best tools. These observations were continued by early humans during the Stone Age as they refined their stone tool making and used mineral pigments for artwork. During the Chalcolithic, Bronze Age, and Iron Age different methods of smelting were discovered and minerals were exploited for various metals.

The earliest well-documented attempt at a scientific study of minerals is *On Stones*, written by Theophrastus in the 3rd Century BC. In this work, Theophrastus attempts to describe the composition of different minerals and includes physical descriptions of each. A few centuries later, Pliny the Elder wrote *Natural History*, an encyclopedia that attempted to compile all the scientific knowledge of the time, including a section on minerals. Until the Renaissance, *On Stones* and *Natural History* remained the authoritative texts on minerals.

MARBODAEI
GALLI CAENOMANENSIS DE
gemmarum lapidumq; pretiosorum formis, naturis, atq; uiribus eruditũ cũ primis opusculũ, sane q̃utile, cum ad rei medicæ, tũ scripturæ sacræ cognitionẽ: nũc primũ nõ mõ cẽtũ ferme uersib. locupletatũ pariter & accuratius emẽdatũ, sed & scholijs q̃q; illustratũ p Alardũ AEmstelredamũ

Cuius studio additæ sunt & præcipuæ gemmarũ lapidũq; ptiosorũ explicatiões, ex uetustiss. qbusq; autorib' coactæ. Cũ scholijs Pictorij Villingeñ.

Ἐν μαργάριτον τίμιον. Ἀποδοὺς ἅπαντα λάμβανε.
En margaritũ nobile, Eme si cupis ditescere.
Rationale. Exodi. 28. & 39. Leui. 8.

Doctrina & Veritas

3 Smaragdus Leui	4 Carbũcul'. Iuda	5 Saphirus Zabulon
2 Topazius Simeon	9 amethystus Aser	6 Iaspis Isachar
1 Sardius Ruben	10 chrysolitus Nepthalim	7 Lincurius Dan
12 Beryllus Beniamin	11 Onychinus Ioseph	8 Achates Gad

Coloniæ excudebat Hero Alopecius Anno. 1539.

A page from Marbod of Rennes medieval work, "Liber de lapidibus (*Book of Stones*)."

René Just Haüy, for which the mineral Haüyne is named after.

In the Middle Ages, lapidaries became very popular. These books included physical descriptions of minerals, but added many magical, medicinal, moral, and protective properties. During the Renaissance, attention shifted from alleged supernatural qualities of minerals to experimentation and observation, ultimately leading to important discoveries such as the crystalline structure of minerals.

In the 19th Century, the polarizing microscope and method for creating thin sections were developed, resulting in the discovery of many previously unknown mineral species. One of the most important developments of this time was James Dwight Dana's system of mineralogy, which classifies minerals based on chemistry and crystal structure. With the discovery of X-rays, mineralogy further advanced with the use of X-ray diffraction to calculate the distribution of atoms in the crystal lattice. In the mid-20th Century, the scanning electron microscope and microprobe were developed, further increasing the number of known minerals.

Currently, around 5,400 mineral species are recognised. Just as Pliny the Elder attempted to compile and disseminate scientific information in the 1st Century AD, today Mindat is an online collection of data concerning the vast universe of minerals including physical characteristics, petrographic data, crystallography, localities, and other information available to anyone with internet access.

Notes